

What Is Claimed Is:

- 1 1. A method for reducing data burst overhead in an Ethernet passive
2 optical network which includes a central node and at least one remote node,
3 wherein downstream data from the central node is broadcast to the remote nodes,
4 and wherein upstream data from each remote node is transmitted to the central
5 node in a unicast manner, the method comprising:
6 transmitting grant messages to a number of remote nodes, wherein a grant
7 message for a specified remote node assigns a start time and a duration of a
8 transmission timeslot in which the specified remote node may transmit a upstream
9 data burst; and
10 receiving a number of upstream data bursts, wherein the time gap between
11 two consecutive upstream data bursts is less than the summation of a default laser
12 turn-on time, a default laser turn-off time, an automatic gain control (AGC)
13 period, and a clock and data recovery (CDR) period.
- 1 2. The method of claim 1, wherein a preceding upstream data burst's
2 laser turn-off period overlaps with a subsequent data burst's laser turn-on period.
- 1 3. The method of claim 2, wherein the non-overlapping portion of
2 the preceding data burst's laser turn-off period is equal to or greater than twice
3 the allowed maximum jitter of the round-trip time between the central node and a
4 remote node; and
5 wherein the non-overlapping portion of the subsequent data burst's laser
6 turn-on period is equal to or greater than twice the allowed maximum jitter of the
7 round-trip time between the central node and a remote node.

1 4. The method of claim 2, wherein a grant message specifies a
2 transmission timeslot start time that is earlier than the ending time of an
3 immediately preceding transmission timeslot.

1 5. The method of claim 1, wherein receiving a number of upstream
2 data bursts involves receiving a number of consecutive data bursts from a remote
3 node, wherein the remote node is allowed to transmit the number of consecutive
4 data bursts without turning off and turning on its laser between two consecutive
5 data bursts.

1 6. The method of claim 5, further comprising detecting the time gap
2 between two consecutive transmission timeslots assigned to the remote node; and
3 if the time gap is less than a pre-defined value, allowing the remote node
4 to transmit upstream data during the time gap without turning off and turning on
5 its laser.

1 7. The method of claim 1, wherein if one or more remote nodes are
2 virtual remote nodes located in a common physical remote node, and if these
3 virtual remote nodes transmit upstream data through a common laser belonging
4 to the common physical remote node, the method further comprises:
5 allowing the common laser to keep transmitting upstream data without
6 being turned off between consecutive transmission timeslots assigned to one or
7 more virtual remote nodes located in the common physical remote node.

1 8. The method of claim 7, wherein a grant message contains a
2 laser-turn-on flag and a laser-turn-off flag;

3 wherein if a grant message's laser-turn-on flag is true, the corresponding
4 remote node turns on its laser at the start time of its assigned transmission
5 timeslot and transmits an AGC bit sequence and a CDR bit sequence before
6 transmitting upstream data;
7 wherein if a grant message's laser-turn-on flag is false, the corresponding
8 remote node immediately starts transmitting upstream data at the start time of its
9 assigned transmission timeslot without transmitting an AGC bit sequence and a
10 CDR bit sequence;
11 wherein if a grant message's laser-turn-off flag is true, the corresponding
12 remote node turns off its laser after transmitting upstream data; and
13 wherein if a grant message's laser-turn-off flag is false, the corresponding
14 remote node continues transmitting data until the end of its assigned transmission
15 timeslot without turning off its laser.

1 9. The method of claim 7, wherein if one or more remote nodes are
2 virtual remote nodes located in a common physical remote node, and if these
3 virtual remote nodes transmit upstream data through a common laser belonging
4 to the common physical remote node, the method further comprises allowing the
5 common laser to keep transmitting the upstream data bursts without being turned
6 off between consecutive transmission timeslots assigned to one or more virtual
7 remote nodes located in the common physical remote node.

1 10. The method of claim 1, further comprising receiving an actual
2 laser turn-on time and an actual laser turn-off time from a remote node;
3 wherein the actual laser turn-on and turn-off times specify the amount of
4 time required by the remote node to turn on and turn off its laser, respectively.

1 11. The method of claim 10, wherein the actual laser turn-on and turn-
2 off times are transmitted with a registration message from the remote node when
3 the central node initially registers the remote node.

1 12. The method of claim 10, wherein a grant message assigns a start
2 time and a duration of a transmission timeslot based on the actual laser turn-on
3 and turn-off times of the remote node to which the grant message is destined.

1 13. An apparatus for reducing data burst overhead in an Ethernet
2 passive optical network, comprising:
3 at least one remote node; and
4 a central node configured to,
5 transmit grant messages to a number of remote nodes, wherein a
6 grant message for a specified remote node assigns a start time and a
7 duration of a transmission timeslot in which the specified remote node
8 may transmit a upstream data burst; and
9 receive a number of upstream data bursts, wherein the time gap
10 between two consecutive upstream data bursts is less than the summation
11 of a default laser turn-on time, a default laser turn-off time, an AGC
12 period, and a CDR period;
13 wherein the central node is configured to broadcast downstream data to the
14 remote nodes; and
15 wherein each remote node is configured to transmit upstream data to the
16 central node in a unicast manner.

1 14. The apparatus of claim 13, wherein a preceding upstream data
2 burst's laser turn-off period overlaps with a subsequent data burst's laser turn-on
3 period.

1 15. The apparatus of claim 14, wherein the non-overlapping portion
2 of the preceding data burst's laser turn-off period is equal to or greater than twice
3 the allowed maximum jitter of the round-trip time between the central node and a
4 remote node; and

5 wherein the non-overlapping portion of the subsequent data burst's laser
6 turn-on period is equal to or greater than twice the allowed maximum jitter of the
7 round-trip time between the central node and a remote node.

1 16. The apparatus of claim 14, wherein a grant message specifies a
2 transmission timeslot start time that is earlier than the ending time of an
3 immediately preceding transmission timeslot.

1 17. The apparatus of claim 13, wherein a remote node is configured to
2 transmit a number of consecutive data bursts without turning off and turning on
3 its laser between two consecutive data bursts.

1 18. The apparatus of claim 17, wherein the remote node is further
2 configured to detect the time gap between two consecutive transmission timeslots
3 assigned to the remote node; and

4 if the time gap is less than a pre-defined value, allow the remote node to
5 transmit upstream data during the time gap without turning off and turning on its
6 laser.

1 19. The apparatus of claim 13, wherein if one or more remote nodes
2 are virtual remote nodes located in a common physical remote node, and if these
3 virtual remote nodes transmit upstream data through a common laser belonging
4 to the common physical remote node, the common physical remote node is
5 configured to:

6 allow the common laser to keep transmitting upstream data without being
7 turned off between consecutive transmission timeslots assigned to one or more
8 virtual remote nodes located in the common physical remote node.

1 20. The apparatus of claim 19, wherein a grant message contains a
2 laser-turn-on flag and a laser-turn-off flag;

3 wherein if a grant message's laser-turn-on flag is true, the corresponding
4 remote node is configured to turn on its laser at the start time of its assigned
5 transmission timeslot and transmits an AGC bit sequence and a CDR bit
6 sequence before transmitting upstream data;

7 wherein if a grant message's laser-turn-on flag is false, the corresponding
8 remote node is configured to start immediately transmitting upstream data at the
9 start time of its assigned transmission timeslot without transmitting an AGC bit
10 sequence and a CDR bit sequence;

11 wherein if a grant message's laser-turn-off flag is true, the corresponding
12 remote node is configured to turn off its laser after transmitting upstream data;
13 and

14 wherein if a grant message's laser-turn-off flag is false, the corresponding
15 remote node is configured to continue transmitting data until the end of its
16 assigned transmission timeslot without turning off its laser.

1 21. The apparatus of claim 19, wherein if one or more remote nodes
2 are virtual remote nodes located in a common physical remote node, and if these
3 virtual remote nodes transmit upstream data through a common laser belonging
4 to the common physical remote node, the physical remote node is further
5 configured to allow the common laser to keep transmitting the upstream data
6 bursts without being turned off between consecutive transmission timeslots
7 assigned to one or more virtual remote nodes located in the common physical
8 remote node.

1 22. The apparatus of claim 13, wherein the central node is further
2 configured to receive an actual laser turn-on time and an actual laser turn-off
3 time from a remote node; and
4 wherein the actual laser turn-on and turn-off times specify the amount of
5 time required by the remote node to turn on and turn off its laser, respectively.

1 23. The apparatus of claim 22, wherein the actual laser turn-on and
2 turn-off times are transmitted with a registration message from the remote node
3 when the central node initially registers the remote node.

1 24. The apparatus of claim 22, wherein a grant message assigns a start
2 time and a duration of a transmission timeslot based on the actual laser turn-on
3 and turn-off times of the remote node to which the grant message is destined.

1 25. A computer-readable storage medium storing instructions that
2 when executed by a computer cause the computer to perform a method for
3 reducing data burst overhead in an Ethernet passive optical network which
4 includes a central node and at least one remote node, wherein downstream data

5 from the central node is broadcast to the remote nodes, and wherein upstream
6 data from each remote node is transmitted to the central node in a unicast
7 manner, the method comprising:
8 transmitting grant messages to a number of remote nodes, wherein a grant
9 message for a specified remote node assigns a start time and a duration of a
10 transmission timeslot in which the specified remote node may transmit a upstream
11 data burst; and
12 receiving a number of upstream data bursts, wherein the time gap between
13 two consecutive upstream data bursts is less than the summation of a default laser
14 turn-on time, a default laser turn-off time, an automatic gain control (AGC)
15 period, and a clock and data recovery (CDR) period.

1 26. The computer-readable storage medium of claim 25, wherein a
2 preceding upstream data burst's laser turn-off period overlaps with a subsequent
3 data burst's laser turn-on period.

1 27. The computer-readable storage medium of claim 26, wherein the
2 non-overlapping portion of the preceding data burst's laser turn-off period is
3 equal to or greater than twice the allowed maximum jitter of the round-trip time
4 between the central node and a remote node; and
5 wherein the non-overlapping portion of the subsequent data burst's laser
6 turn-on period is equal to or greater than twice the allowed maximum jitter of the
7 round-trip time between the central node and a remote node.

1 28. The computer-readable storage medium of claim 26, wherein a
2 grant message specifies a transmission timeslot start time that is earlier than the
3 ending time of an immediately preceding transmission timeslot.

1 29. The computer-readable storage medium of claim 25, wherein
2 receiving a number of upstream data bursts involves receiving a number of
3 consecutive data bursts from a remote node, wherein the remote node is allowed
4 to transmit the number of consecutive data bursts without turning off and turning
5 on its laser between two consecutive data bursts.

1 30. The computer-readable storage medium of claim 29, wherein the
2 method further comprises detecting the time gap between two consecutive
3 transmission timeslots assigned to the remote node; and
4 if the time gap is less than a pre-defined value, allowing the remote node
5 to transmit upstream data during the time gap without turning off and turning on
6 its laser.

1 31. The computer-readable storage medium of claim 25, wherein if
2 one or more remote nodes are virtual remote nodes located in a common physical
3 remote node, and if these virtual remote nodes transmit upstream data through a
4 common laser belonging to the common physical remote node, the method
5 further comprises:
6 allowing the common laser to keep transmitting upstream data without
7 being turned off between consecutive transmission timeslots assigned to one or
8 more virtual remote nodes located in the common physical remote node.

1 32. The computer-readable storage medium of claim 31, wherein a
2 grant message contains a laser-turn-on flag and a laser-turn-off flag;
3 wherein if a grant message's laser-turn-on flag is true, the corresponding
4 remote node turns on its laser at the start time of its assigned transmission

5 timeslot and transmits an AGC bit sequence and a CDR bit sequence before
6 transmitting upstream data;
7 wherein if a grant message's laser-turn-on flag is false, the corresponding
8 remote node immediately starts transmitting upstream data at the start time of its
9 assigned transmission timeslot without transmitting an AGC bit sequence and a
10 CDR bit sequence;
11 wherein if a grant message's laser-turn-off flag is true, the corresponding
12 remote node turns off its laser after transmitting upstream data; and
13 wherein if a grant message's laser-turn-off flag is false, the corresponding
14 remote node continues transmitting data until the end of its assigned transmission
15 timeslot without turning off its laser.

1 33. The computer-readable storage medium of claim 31, wherein if
2 one or more remote nodes are virtual remote nodes located in a common physical
3 remote node, and if these virtual remote nodes transmit upstream data through a
4 common laser belonging to the common physical remote node, the method
5 further comprises allowing the common laser to keep transmitting the upstream
6 data bursts without being turned off between consecutive transmission timeslots
7 assigned to one or more virtual remote nodes located in the common physical
8 remote node.

1 34. The computer-readable storage medium of claim 25, wherein the
2 method further comprises receiving an actual laser turn-on time and an actual
3 laser turn-off time from a remote node; and
4 wherein the actual laser turn-on and turn-off times specify the amount of
5 time required by the remote node to turn on and turn off its laser, respectively.

1 35. The computer-readable storage medium of claim 34, wherein the
2 actual laser turn-on and turn-off times are transmitted with a registration message
3 from the remote node when the central node initially registers the remote node.

1 36. The computer-readable storage medium of claim 34, wherein a
2 grant message assigns a start time and a duration of a transmission timeslot based
3 on the actual laser turn-on and turn-off times of the remote node to which the
4 grant message is destined.